OPEN ACCESS

ISSN1927-6648

International Journal of Marine Science

ISSN 1927-6648
Published by BioPublisher
http://biopublisher.ca
2017
Volume 7

Publisher

Sophia Publishing Group

Edited by

Editorial Team of International Journal of Marine Science

Email: edit@ijms.biopublisher.ca
Website: http://biopublisher.ca/index.php/ijms

Address:
11388 Stevenston Hwy,
PO Box 96016,
Richmond, V7A 5J5, British Columbia
Canada

International Journal of Marine Science (ISSN 1927-6648) is an open access, peer reviewed journal published online by BioPublisher.

The journal publishes all the latest and outstanding research articles, letters and reviews in all areas of marine science, the range of topics containing the advancement of scientific and engineering knowledge regarding the sea; from chemical and physical to biological oceanography, from estuaries and coastal waters to the open ocean; as well as including fisheries, socio-economic science, co-management, ecosystems and other topical advisory subjects.

BioPublisher, operated by Sophia Publishing Group (SPG), is an international Open Access publishing platform that publishes scientific journals in the field of life science. Sophia Publishing Group (SPG), founded in British Columbia of Canada, is a multilingual publisher.

All the articles published in International Journal of Marine Science are Open Access, and are distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

BioPublisher uses CrossCheck service to identify academic plagiarism through the world's leading plagiarism prevention tool, iParadigms, and to protect the original authors' copyrights.

© 2017 BioPublisher, an online publishing platform of Sophia Publishing Group. All Rights Reserved.
Sophia Publishing Group (SPG), founded in British Columbia of Canada, is a multilingual publisher.

Latest Content

BioPublisher©

International Journal of Marine Science, 2017, Vol.7, No.1, 1-7
http://ijms.biopublisher.ca

Research Report Open Access

Total Petroleum Hydrocarbon in Selected Fish of Shatt Al-Arab River, Iraq

Al-Saad H.T. [1], Al-Ali B.S. [2], Al-Anber L.J. [2], Al-Khion D.D. [2], Hantoush A.A. [2], Saleh S.M. [2], Alaial A.H. [2]

1 College of Marine Science, University of Basrah, Iraq

2 Department of Marine Environmental Chemistry- Marine Science Center, University of Basrah, Iraq

Corresponding author email: htalsaad@yahoo.com

International Journal of Marine Science, 2017, Vol.7, No. 1 doi: 10.5376/ijms.2017.07.0001

Received: 8 Dec., 2016

Accepted: 9 Dec., 2016

Published: 10 Jan., 2017

Copyright © 2017 Al-Saad et al., This is an open access article published under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Preferred citation for this article:

Al-Saad H.T., Al-Ali B.S., Al-Anber L.J., Al-Khion D.D., Hantoush A.A., Saleh S.M., and Aleal A.H., 2017, Total petroleum hydrocarbon in selected fish of Shatt Al-Arab River, Iraq, International Journal of Marine Science, 7(1): 1-7 (doi: 10.5376/ijms.2017.07.0001)

Abstract This study represents the concentrations of TPH in six commercial *Luciobarbus xanthopterus*, *Ctenophyngodon idella*, *Cyprinus carpio*, *Tilapia zillii*, *Palaniza abu* and *Leuciscus vorax* from Shatt Al-Arab River. The highest concentrations of TPH were found in *Leuciscus vorax* in during Summer 21.52±3.41 µg/g (dry wt.) and the lowest in *Tilapia zillii*2.47±0.33 µg/g (dry wt.), while highest concentrations during winter found in *Cyprinus carpio* 8.2±1.0 µg/g (dry wt.), which is more than other fishes and the low concentration 0.33 µg were found in *Tilapia zillii*with level of 2.47±/g (dry wt.). The concentration in fish samples ordering as the following: *Luciscus vorax* > *Cyprinus carpio* > *Ctenophyngodon idella* > *Luciobarbus xanthopterus* > *Palaniza abu* > *Tilapia zillii*. This is may be due to the variety of fish feeding habitat and the season of reproduction , also the hydrocarbons found in the fish species of Shatt Al-Arab river are due to food and water sources, type of habitat, environmental factors, and lipid content.

Keywords Total petroleum hydrocarbons; Fishes; Shatt AL-Arab; Iraq

Introduction

The Iraqi freshwater environment, suffered from various types of pollution especially that related to pesticides, hydrocarbons or heavy metal toxicants. The numerous of oil exploration and exploitation activities in economies that produce and consume oil products to appear crude oil pollution as a natural consequence (Osuagwu et al., 2013).

Hydrocarbons are a common and natural occurrence in the environment and varying concentrations in storm water and effluent water are not unusual. Hydrocarbons in water can be found as free floating, emulsified, dissolved, or adsorbed to suspended solids. A hydrocarbon, by definition, is one of a group of chemical compounds composed only of hydrogen and carbon. Typically, hydrocarbons are broken down into three main classes; aliphatic, alicyclic, and aromatics. Further sub-classes can also be defined. Simply stated though, hydrocarbons are organic compounds made up of hydrogen and carbon (Reeves, 2000).

Petroleum hydrocarbons (PHCs) originally from oil and its derivatives existing either naturally from seepage of crude oil (Klenkin et al., 2010), or anthrapoginically as a result of human being activities (Heras et al., 1992; Al-Hejuje et al., 2015). This anthrapoginically pollution is due mainly to accidental discharge human error, sabotage, transportation and other natural causes. there is a significant spillage of oil into the environment from a number of sources including damaged oil tankers, storage vehicles, leakages of oil pipelines, oil tankers overflow (Agbogidi, 2005; Osuagwu et al., 2013).

The diffusion of pollutants (pesticides, petroleum oils and trace elements and other pollutants) in the aquatic environment specially rivers can cause deleterious effects on biota, effects which are not visible and may come to light after a long period of time (Sharma and Cyril, 2007).

There is a potential environmental risk of spills when using these materials, contaminated water may present opportunities for research on the effects of PHCs on existing aquatic organisms such as zooplankton. Other sources of pollution by PHC's arise from the different types of waste and sewage (Heras et al., 1992).

The aquatic organisms swallow petroleum hydrocarbons from the aquatic environment either from the water or from the suspended solids or with food or sediment (Heras et al., 1992; GESAMP, 1993; Cripps and Priddle, 1995).

GESAMP (1993) and Al-Saad et al. (2003) stated that the hydrocarbon pollutants have indirect effects on fishes as they cause the destruction or death of aquatic grasses, aquatic plants, coral reefs, zooplankton and phytoplankton which are used as a source of protection for the growth of larvae and small fishes or as a food for these animals.

Among these aquatic organisms fishes are known to be most sensitive to hydrocarbon compounds, leading to several specific and non-specific responses by their immune system. The specific responses may be intended to production of antibodies, and the unspecific responses may involve effects on increased activities such as lysozyme and/or phagocytosis (Reynaud and Deschaux, 2006).

In Basrah city are producing and exporting about two million barrels, which in turn leads to increased pollution of the marine environment and spread to river water environment, especially where the Shatt al-Arab is characterized by many of the loading and discharge petroleum products areas. Present study provides information on total petroleum hydrocarbons (TPHs) in six commercial fish species from Shatt Al-Arab River in Basrah city which used in later studies.

1 Materials and Methods

Shatt Al-Arab formed by the confluence of the Euphrates and the Tigris River at Al-Qurnah in Basrah city of southern Iraq. The southern end of the river constitutes the border between Iraq and Iran down to the mouth of the river as it discharges into the Arabian Gulf. A variety of industries, including refineries and petrochemical complexes, from this area release their effluents into the water such as Abadan oil refinery there are number of ports where in the ship and cargo handling activities contribute to Shatt Al-Arab River.

Freshwater fish samples were collected during summer (June, July and August) and winter (December, January and February) (2014-2015). Six economic species of freshwater fish locations were collected with the help of local fisherman of the region from Shatt Al-Arab River, named and the morphometric measurements were taken immediately (Table 1).

Table 1 Detailed information of the collected fish samples from Shatt Al-Arab

Fish species	Common name	Habitat	Feeding habit Coad, 2010	No. of fish	Total Weight (g)	Total Length (cm)	Fat (%)
Luciobarbus xanthopterus	Cattan	native	Carnivores	10	916	40	7.5
Ctenophyngodon idella	Gareeba	foreign	Herbivorous	18	1117	57	2.72
Cyprinus carpio	Samti	foreign	Omnivorous	30	1019	35	2.6
Tilapia zillii	Bultti	foreign	Omnivorous	60	75	15	2.5
Palaniza abu	Khishni	native	detritus and phytoplankton feeding	46	43	21	3.5
Leuciscus vorax	Shillig	native	Carnivores	30	750	35	2.5

Fish samples were stored in pollution-free sealed polythene covers and transported to the laboratory at Marine science center, in ice box and stored at −20℃ in the deep freezer until analysis. Fish samples were taken out from the deep freezer, thawed, and well cleaned in tap water to remove any external dirt. Edible muscle tissue without the skin and bone were used in the chemical analysis. Information regarding species, lipid content, length and weight is presented in Table 1.

Muscle samples were freeze dried, then sample was ground, and twenty five grams weighed was packed in a thimble (Whatman) and desiccated overnight prior to extraction.

The desiccated thimble was extracted using Soxhlet apparatus with Methanol: Benzene solvent for 24 hours as the methods described by (Grimalt and Oliver, 1993). The solvent was reduced and an aliquot was taken for lipid estimation. Another aliquot was subjected to removal of other contaminants by passing the sample throw silica gel-alumina column. The instrumental analysis of TPHs was carried with UV fluorescence, using Basrah crude oil standard. Quantification was performed at 310 and 360 nm as excitation and emission wavelengths, respectively (Moopam, 2005).

2 Results and Discussion

Information regarding species, the length, weight, Fat % and concentration of total petroleum hydrocarbons in the selected commercial fish species *Luciobarbus xanthopterus*, *Ctenophyngodon idella*, *Cyprinus carpio*, *Tilapia zillii*, *Palaniza abu* and *Leuciscus vorax* presented in Table 1 and Table 2.

Table 2 Levels (means ±SD) and average of TPH (μg/g dry wt.) during two seasons

Fish Species	Summer	Winter	Average
Luciobarbus xanthopterus	5.18± 0.29	6.21±0.09	5.695
Ctenophyngodon idella	6.41±1.49	6.98±1.34	6.695
Cyprinus carpio	7.21±0.29	8.20 ±1.00	7.705
Tilapia zillii	2.47±0.33	3.10 ±0.20	2.785
Palaniza abu	3.43±0.35	4.05±0.95	3.74
Leuciscus vorax	21.52±3.41	5.12±0.32	13.32

The result in Table 2 show variation in total petroleum hydrocarbons among six fish species which was the highest in *Leuciscus vorax* in summer 21.52±3.41 μg/g (dry wt.) and the lowest in *Tilapia zillii* 2.47±0.33 μg/g (dry wt.), while in winter *Cyprinus carpio* was 8.2±1.0 μg/g (dry wt.) more than other fishes and the low concentration was found in *Tilapia zillii* too with level 2.47±0.33 μg/g (dry wt.). The mean of summer and winter is shown in Table 2 and Figure 1.

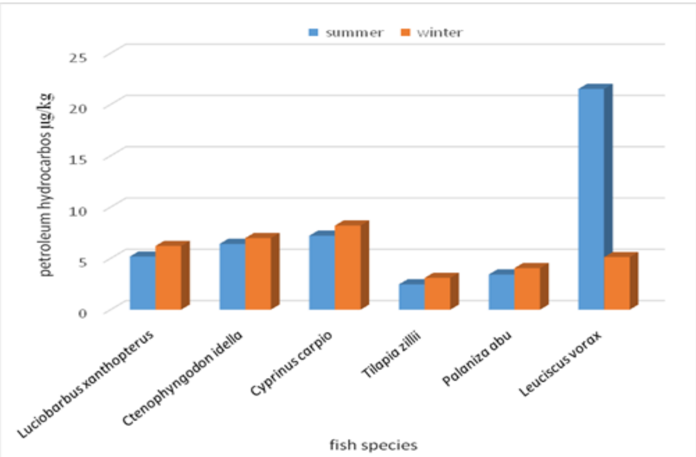

Figure 1 Petroleum hydrocarbon in fish species (μg/g dry wt.) from Shatt Al-Arab River in summer and winter (2014-2015)

The percentage levels of TPH in fish were high in *Leuciscus vorax* 33% and *Tilapia zillii* have 7% lower than other fish. And according to the Figure 2 the fish ordering as the following: *Leuciscus vorax* > *Cyprinus carpio* > *Ctenophyngodon idella* > *Luciobarbus xanthopterus* > *Palaniza abu* > *Tilapia zillii*. This is may be due to the variety of fish feeding habitat and the season of reproduction. It is very common that fish and other aquatic have the ability to accumulation of petroleum products (Asuquo and Udoh, 2002).

The oil pollution of shatt Al-Arab due to the Industeral oil production activity and exploration and water Balance discharge. Hydrocarbons as soluble or as tar particles can enter fish through the water, primarily through the gills or from their food by feeding on polluted prier (Al-Saad and Al-ASadi, 1989).

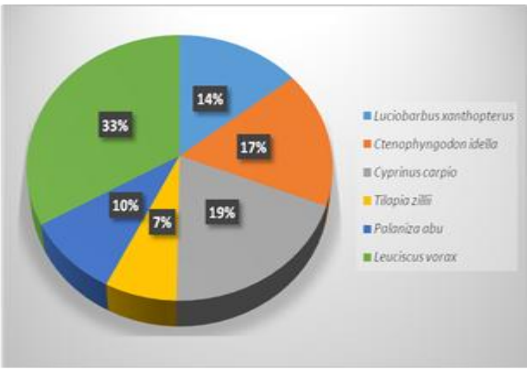

Figure 2 Average percentage of total petroleum hydrocarbons (μg/g dry wt.)

In this study levels of TPH was close to or higher than as Salman (2011) reported in Um Al-Ward (2.46-3.23) μg/g; Al-Bagdadia (4.79-6.87) μg/g; Al-Nagarah (3.31-3.60) μg/g; Al-Bargah (1.51-2.76) μg/g. Due to increased oil activity in the Shatt al-Arab through the loading and unloading of ships and through the tides.

Atti (2014) reported the maximum value of petroleum hydrocarbons concentration in the muscles of green mullet *Liza subviridis* fish was recorded during winter (8.95 μg/g), whereas the highest value in the muscles of gold mullet *Liza klunzingeri* fish was recorded during spring (9.85 μg/g).The lowest values recorded in summer for both tissues in green and golden mullet fish In Shatt Al-Basrah. While (Al-Saad et al., 2015) found that the highest concentrations of *L. abu* species was 37.3 μg/g dry weight during summer in the treatment unit station, while the lowest concentrations 4.81 μg/g dry weight was recorded during spring in reference station. Whereas for *C. auratus* species the highest concentrations 29.303 μg/g dry weight was recorded during autumn in the treatment unit station, while the lowest concentrations 2.51 μg/g dry weight was recorded during spring in reference station they found that *L. abu* species have more ability to accumulate TPHs in their tissues compared with *C. auratus* species. Al-Ali et al. (2016) found that the levels of total Petroleum Hydrocarbons (TPH) in fourteen commercially important fish species from the Iraqi coastal water in North West Arabian Gulf during summer and winter (2014-2015). PHC residues in fourteen fish species varied between 2.45 and 6.85 μg/g (dry wt.) in summer and 2.64 and 7.65 μg/g (dry wt.) in winter. Among the fourteen *Tenualosa ilisha* showed the highest level of TPH in both season summer and winter (6.85 ± 0.29, 7.65 ± 0.31 μg/g) respectively in the muscle tissue followed by *Euryglossa orientalis* (2.45 ± 0.3, 2.64 ± 0.06 μg/g) respectively also in both seasons. Also, we found that the *Leuciscus vorax* have the highest concentration of petroleum hydrocarbons compared with other fish.

Al-Saad et al. (2008) observed the mean concentrations of petroleum hydrocarbons in *Tenualosa ilisha* fish were different due to its lengths and to the month in which has been capture. The lower mean concentration were observed during September in lengths (20±2 cm) value 0.29 μg/g dry weight expressed as Basra crude oil equivalent, with fat content (45.51%),while higher values of petroleum hydrocarbons observed during March-May in lengths (40±2 cm) mean 8.89-5.34 ug/g dry weight and high values of fat % (54.17-78.10) respectively.

Al-Saad et al. (2008) reported the hydrocarbons concentration decrease with the decrease of the lengths of fish and also during the months, this may be due to the fat contain of fish which differ in age stages. Asuquo and Udoh (2002) found the levels of total hydrocarbons in fish from Cross river Estuary in Nigeria greater than 6 (*Ethmalosa fimbriata* 6.91±0.37 and *Chrysichthys nigrodigitatus*14.78±1.33 (ppm) and they found that depending on the season which was greater in wet season Al-Saad (1995) reported that many aquatic organisms of Shatt Al-Arab river including plants, algae, zooplankton, bacteria and fish were capable to synthesize biogenic hydrocarbons. There are many factors that affect the distribution of hydrocarbons in Shatt Al-Arab River (which accumulated later in the tissues of fish) such as, volatilization, mixing, flushing adsorption, chemical oxidation, photo-decomposition, sedimentation, and biodegradation. These factors collectively reduce the concentration of hydrocarbons compounds (Al-Saad, 1995). Our data indicate that the level of Total petroleum Hydrocarbons which observed in selected fish lie within the range of values reported for comparable areas (Table 3).

Table 3 Comparison of petroleum hydrocarbon concentration (μg/g dry wt.) in fish samples from Shatt Al-Arab River with those from selected marine areas

Stations	Conc. (μ g/g)	References
Hor Al-Howaiza	1.09 - 11.11	Al-Khatib (2008)
Um Al-Ward	2.46 - 3.23	
Hor Al-Hammar, Iraq	1.945 - 4.011	Talal (2008)
Euphrates River, Nasiria City	6.01 - 13.63	Abed Ali (2013)
Southern Iraqi Marshes	1.15 - 27.42	Abdul Rehman (2010)
Al-Kahlaa River, Missan City	2.51 - 37.30	Al-Saad et al., (2015)
Al-Bagdadia	4.79 - 6.87	Salman (2011)
Al-Nagarah	3.31 - 3.60	
Al-Bargah	1.51 - 2.76	
Arabian Gulf	4.80 -7.40	Ashraf and Mian, (2010)
Shatt Al-Arab	29.60 -45.90	Al-Saad and Al-Asadi (1989)
Red Sea of Yemen	0.10 - 1.30	Nabil and Al-Shwafi (2008)
Gulf of Aden	0.20 - 1.30	
Arabian Gulf	0.57 - 3.67	Nozar et al.(2015)
Shatt Al-Arab estuary and NW Arabian Gulf	1.70 - 10.91	Al-Saad et al.(1997)
Shatt Al-Arab estuary and NW Arabian Gulf	2.60 - 12.55	Hantoush et al. (2001)
Khor Al-Zubair	8.30 - 40.60	Al-Saad (1990)
Iraqi Marine Water	11.44 - 48.16	Nasir (2007)
Al-Fao and Khor Abdullah	0.23 - 54.46	Al-Khion(2012)
Iraqi marine waters	2.55 - 7.25	Al-Ali et al.(2016)
Shatt Al-Arab	2.785- 13.32	Current study

3 Conclusions

The species of fish species from Shatt Al-Arab River were found to contain measurable amount of hydrocarbons. The hydrocarbons found in the species of fishes of Shatt Al-Arab River are due to food and water sources, type of habitat, environmental factors, and lipid content.we found that the *Leuciscus vorax* have the highest concentration of petroleum hydrocarbons compared with other fish. All this species are commercial and eaten by people, from the present study it can be concluded that TPH levels are not as high as could be expected in the Gulf, therefore, consumption of these fish species does not pose a significant health risk to the local population.

Authors' Contributions

Al-Ali B.S., Al-Anber L.J. and Al-Khion D.D. conceived and designed the experiments. Hantoush A.A., Saleh S.M., and Aleal A.H. analysed the data. AL-Saad,H.T and Al-Ali B.S. wrote the first draft of the manuscript. Al-Anber L.J. and Al-Khion D.D. contributed to the writing of the manuscript. Hantoush A.A., Saleh S.M., and Aleal A.H. agree with manuscript results and conclusions. AL-Saad,H.T and Al-Ali B.S. jointly developed the structure and arguments for the paper. AL-Saad H.T made critical revisions and approved final version. All authors reviewed and approved of the final manuscript.

Acknowledgements

The researchers wish to acknowledge the Marine Science Center (University of Basra) for providing laboratory facilities.

References

Abdul-Rehman B.A., 2010, The assessment of accumulation of petroleum hydrocarbons in the muscles of some fishes in Al-Hammar and Al-Hawizeh marshes, south Iraq. M.Sc thesis, College of Science, University of Basrah, p. 105

Abed Ali S.T., 2013, Seasonal and situational changes to hydrocarbons concentrations and n-alkane origin to samples from water, sediments and biota in Euphrates river near Al-Nasiriya city. M.Sc thesis, College of Science, University of Thi-Qar, p. 127

Agbogidi, O.M., and Ejemete O.R., 2005, An assessment of the effects of crude oil pollution on soil properties, germination and growth of Gambaya albida (L.).Uniswa Research Journal of Agriculture, Science and Technology, 8(2): 148-155

Al-Ali B.S., Al-Bidhani M.F., Al-Khion D.D., Al-Nagar G.A., Al-Saad H.T., Khwadem A.A., Zeidan A.M., Mahdi S., and Hantoush A.A., 2016, Environmental Assessment of Petroleum Hydrocarbons in fish species from North-West Arabian Gulf. J Pharm Chem Biol Sci, June-August 2016, 4(2):126-134

Al-Hejuje M.M., Hussain N.A., and Al-Saad H.T., 2015, Total Petroleum Hydrocarbons (TPHs), n-alkanes and Polynuclear Aromatic Hydrocarbons (PAHs) in Water of Shatt Al-Arab River-Part 1. Global Journal of Biology, Agriculture and Health Sciences, 4(1): 88-94

Al-Khatib F. M., 2008, Determination the concentrations, origin and distribution of hydrocarbon compounds in water, sediments and some biota of Hor Al-Howaiza ,south of Iraq and their sources. Ph.D. Thesis. University of Basrah, college of science, biology department, p. 228

Al-Khion D.D., 2012, Sources and distribution of polycyclic aromatic hydrocarbons compounds in water, sediments and some biota of Iraqi coast regions. Ph.D. Thesis , College of Agriculture ,University of Basrah, p. 171

Al-Saad H.T., Saeed A., and Salman, N.A., 2003, Marine pollution, Hadida University Pub, Yamen, p. 260

Al-Saad H. T., DouAbul A. A., Abd I. M., and Zukhai M. K., 2008, Uptake –release of pollutant by hilsa shad Tenualosa ilisha (Hamilton-Buchanan) fish collected from southern Iraq. Marina Mesopotamica, 23 (2): 237-255

Al-Saad H.T., 1990, Hydrocarbons residence in fishes from–Khor Al-Zubair, N.W. Arabian Gulf. Mar. Mesopot, 5(1): 81-88

Al-Saad H.T., and Al-Asadi M.K., 1989, Petroleum hydrocarbon concentrations in fishes from Shatt Al-Arab River. Marina Mesopotamica, 4(2): 233-242

Al-Saad H.T., Jazza S.H., and Al-Adhub A.H., 2015, Temporal and spatial variations of total petroleum hydrocarbon concentrations in two commercial fish species from Al-Kahlaa River in Missan Governorate/Iraq. Journal of International Academic Research for Multidisciplinary, 2(12): 439-445

Al-Saad H.T., Shamshoom S.M., and Abaychi J.K., 1997, Hydrocarbons in fishes from Shatt Al-Arab and N.W. Arabian Gulf Oil spill of 1991. Mar Mesopot, 12(2): 213-231

Al-Saad H.T., 1995, Distribution and source of hydrocarbons in Shatt Al- Arab Estuary and North-West Arabian Gulf. Ph.D thesis, College of Science , University of Basrah, Iraq, p. 186

Ashraf W., and Mian A., 2010, Total petroleum hydrocarbon burden in fish tissues from the Arabian Gulf. Toxicol Environ Chem. 92(2):61-66
https://doi.org/10.1080/02772240902862220

Asuquo F.E., and Udoh J.P., 2002, Patterns of total hydrocarbons, Copper and Iron in some fish from Cross river Estuary, Nigeria. West Africa. J. Appl. Ecol. 3:91-97

Atti R.S., 2014, Estimate levels of petroleum hydrocarbons in green and golden mullet fishes (Liza subviridis, L. klunzingeri) at Shatt Al-Basrah canal. JKAU: Mar. Sci., 25(2): 41-53

Coad B.W., 2010, Freshwater Fishes of Iraq, Pensoft Publishers, Sofia-Moscow, p. 295

Cripps G.C., and Priddle J., 1995, Hydrocarbons content of an Antarctic in faunal bivalve historical record on life cycle changes, Antarctic Science, 7(2): 127-136
https://doi.org/10.1017/S0954102095000186

GESAMP, 1993, IMO/FAO/UNSCO/WHO/IAEA/UN/UNEP, Join Group of Experts on the Scientific Aspect of Marine pollution (GESAMP), Impact of oil and related chemical and wastes on the marine environment, Reports and studies No. 50, IMO, London, p. 180

Hantoush A.A., Al-Imarah F.J., and Abdullah S.B., 2001, Seasonal variation of petroleum hydrocarbon concentration in fish water and marine fishes from Shatt Al-Arab river and N.W. Arabian Gulf. Marina Mesopotamica, 16(2): 441-451

Heras H., Ackman R.G., and Macpherson E.J., 1992, Tainting of Atlantic Salimon (Salmo salar) by petroleum hydrocarbons during a short term exposure. Mar. Poll. Bull. 24(6): 320-315
https://doi.org/10.1016/0025-326X(92)90592-T

Klenkin A.A., Pavlenko L.F., Skrypnik G.V., and Larin A.A., 2010, Biogenic hydrocarbons and their effect on oil pollution estimates of the Sea of Azov. Water Resources Research, 37(5): 699-705
https://doi.org/10.1134/S009780781005009X

Moopam, 1999, Standard methods for chemical analysis of petroleum hydrocarbons, Kuwait: Regional organization for the protection of marine environment

Nasir A.M., 2007, Seasonal variation of the levels of petroleum hydrocarbons, nickel and vanadium metals in water, sediments, some fishes and shrimps from the Iraqi marine waters. Ph.D. thesis, University of Basrah, p. 154

Nozar S.L., Pauzi M. Z., Salarpouri A., Daghooghi B., Salimizadeh M., 2015, Total petroleum hydrocarbons in edible marine biota from Northern Persian Gulf . Environ Monit Assess. 187: 214-219
https://doi.org/10.1007/s10661-015-4443-4
PMid:25819925

Osuagwu A. N., Okigbo A.U., Ekpo I.A., Chukwurah P.N., and Agbor R.B., 2013, Effect of Crude Oil Pollution on Growth Parameters, Chlorophyll Content and Bulbils Yield in Air Potato (Dioscorea bulbifera L.) International Journal of Applied Science and Technology, 3(4): 37-42

Reeves G., 2000, Understanding and Monitoring Hydrocarbons in Water by: Arjay Engineering Ltd., Oakville, Ontario, Canada, September, 1999 revised June, 2000

Reynaud S., and Deschaux P., 2006, The effects of polycyclic aromatic hydrocarbons on the immune system of fish: A review. Aquatic Toxicology, 77(2): 229-238
https://doi.org/10.1016/j.aquatox.2005.10.018
PMid:16380172

Salman N.A., 2011, Assessment of environmental toxicity in Iraqi Southern marshes using fish as bio-indicators. Ekologija, 57(1): 21-29
https://doi.org/10.6001/ekologija.v57i1.1306

Sharma B.S., and Cyril W., 2007, Distribution and abundance of zooplankton in relation to petroleum hydrocarbon content along the coast of Kollam (Quilon), south west coast of India. Journal of Environmental Biology, 28(1): 53-62
PMid:17717986

Talal A.A., 2008, A study for the seasonal and regional variations of hydrocarbon levels and origin of n-alkanes in water, sediments and some species of biota in Hor Al-Hammar Marshes. Ph.D. thesis, College of Science, University of Basrah, p. 166

BioPublisher©

Reasons to publish in BioPublisher

A BioScience Publishing Platform

★ Peer review quickly and professionally
☆ Publish online immediately upon acceptance
★ Deposit permanently and track easily
☆ Access free and open around the world
★ Disseminate multilingual available

Submit your manuscript at: http://biopublisher.ca